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latter observer described them as narrow lines, a second of arc or so in width.

On April 12th J. M. S. saw two of the canals doubled. It may, therefore, be said that the observations of Professor SCHIAPARELLI have been verified by this observer, both as to the narrowness of the canals and as to their duplication. The positions of most of Professor SCHIAPARELLI'S canals have been verified by some one of us.

The mystery still remains why two observers should agree in their own observations, and should disagree with a third and with the discoverer of these phenomena. A remark by Mr. KEELER (*Publ. A. S. P.*, vol. II, p. 165), with regard to the color-correction of the large telescope and its effect on the seeing of faint planetary markings, throws a little light on this question, but fails to explain how three observers of experience, viewing the same object, with the same instrument, at the same time, can obtain such differing impressions. A review of the observations of *Mars* in 1888 shows that the same observers differed in somewhat the same manner at that time; and an examination of the drawings of E. S. H. from 1875* to 1890 shows that this observer has always drawn the canals in one and the same manner. Letters from Professor SCHIAPARELLI say that he has succeeded in obtaining twelve or fifteen excellent drawings during 1890, which confirm his previous discoveries, and which even extend the area over which the doubling of the canals takes place.

E. S. H., J. M. S., J. E. K.

THE FUTURE OF STELLAR PHOTOGRAPHY.

[Extract from a Letter written in 1857 to WM. MITCHELL by G. P. BOND.†]

"As far as I am informed, the attempt to photograph the fixed stars by their own light has been made nowhere else, up to the present date; the rumor of a daguerreotype of a nebula made in Italy some years since was unfounded.

"About seven years since (July 17th, 1850) Mr. WHIPPLE obtained daguerreotype impressions from the image of a *Lyræ* formed in the focus of the Great Equatorial, and subsequently from *Castor*, thus establishing a simple but not uninteresting fact—the possibility of such an achievement. On these occasions a long exposure of one or two minutes was required before the plate was

* See *Mémoires couronnés etc. publiées par l'Académie Royale de Belgique*, vol. XXXI, figs. 1-5 (1875 June-August).

† Professor GEORGE PHILLIPS BOND was then Assistant in the Harvard College Observatory. The extract given above was kindly communicated by his daughters.

acted upon by the light, and in this interval the irregularities of the Munich clock-work were so great as to destroy the symmetry of the images, while the smaller stars of the second magnitude would not 'take' at all.

"For some years after, Mr. WHIPPLE gave his attention to photographs of the moon and sun, and the stars were left to themselves. But improvements in the art progressed rapidly; the preparations were more sensitive; the artists had acquired more experience. At the same time the principle of the spring-governor had been thoroughly tested, and found to supply a great desideratum in imparting a sidereal motion to the telescope, incomparably more uniform than that attained by the Munich mechanism. Messrs. WHIPPLE and BLACK recommenced their trials on star images (taken by the collodion process) in March of the present year, and they are still in progress. The expense of time, chemicals, etc., is far more considerable than one would have anticipated—each night, in fact, opens new vistas requiring exploration. The field for experiment is too vast to be at once occupied, even if we were provided with unlimited means. But the results already obtained in the disconnected attempts we have thus far been enabled to make are of the highest interest, and suggest possibilities in the future which one can scarcely trust himself to speculate upon. Could another step in advance be taken equal to that gained since 1850, the consequences could not fail of being of incalculable importance in Astronomy.

"The same object, *α Lyræ*, which in 1850 required 100 seconds to impart its image to the plate, and even then imperfectly, is now photographed instantaneously with a symmetrical disc, perfectly fit for exact micrometer measurements. We then were confined to a dozen or two of the brightest stars, whereas now we take all that are visible to the naked eye. Even from week to week we can distinguish decided progress.

"Of the beauty and convenience of the method you will scarcely form a correct idea without witnessing for yourself, which I hope you will be able to do before long.

"On a fine night the amount of work which can be accomplished, with entire exemption from the trouble, vexation and fatigue that seldom fail to attend upon ordinary observations, is astonishing. The plates, once secured, can be laid by for future study by daylight and at leisure. The record is there, with no room for doubt or mistake as to its fidelity. As yet, however, we obtain images only from stars to the sixth magnitude inclusive. To be of essential service to

Astronomy, it is indispensable that great improvements be yet made, and these I feel sure will not be accomplished without a deal of experimenting.

“But could we but press the matter on, we should soon be able to say what we can and what we cannot accomplish in stellar photography. The latter limits we certainly have not yet reached. At present the chief object of attention must be to improve the sensitiveness of the plates, to which, I am assured by high authorities in chemistry, there is scarcely any limit to be put in point of theory. Suppose we are able finally to obtain pictures of seventh-magnitude stars. It is reasonable to suppose that, on *some lofty mountain and in a purer atmosphere*, we might, with the same telescope, include the eighth-magnitude. To increase the size of the telescope three-fold in aperture is a practicable thing, if the money can be found. This would increase the brightness of the stellar images, say, eight-fold, and we should be able then to photograph all the stars to the tenth and eleventh magnitude inclusive. There is nothing, then, so extravagant in predicting a future application of photography to stellar Astronomy on a most magnificent scale. It is, even at this moment, simply a question of finding one or two hundred thousand dollars to make the telescope with and to keep up the experiments.

“What more admirable method can be imagined for the study of the orbits of the fixed stars and for resolving the problem of their annual parallax than this would be, if we could obtain the impressions of the telescopic stars to the tenth magnitude? Consider, too, that groups of ten, or fifty even, if so many occur in the compass of the field, will be taken as quickly as one alone would be—perhaps in a few seconds only—and each mapped out with unimpeachable accuracy.

“I have not alluded to two important features in stellar photography. One is that the intensity and size of the images, taken in connection with the length of time during which the plate has been exposed, measures the relative magnitudes of the stars. The other point is that the measurements of distances and angles of position of the double stars from the plates we have ascertained, by many trials on our earliest impressions, to be as exact as the best micrometric work. Our subsequent pictures are much more perfect, and should do better still.” * * *

HARVARD COLLEGE OBSERVATORY, 1857, July 6.